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Virtual Library - Blending Mirror and Fantasy Layers into a VR Interface for a Public Library

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ABSTRACT
We present an immersive VR interface for a public library where a mirror-world like virtual copy of the physical library is blended with imaginary virtual fantasy layers into a hybrid space for library content. The design of the system was guided by multi-stakeholder Participatory Design process involving library staff, library customers and researchers. The findings of the qualitative user evaluation of the prototype suggest that this kind of a VR interface is an exciting extension to a physical library, indicating the unlimited possibilities offered by the VR's ability to send the user into imaginary places.

CCS Concepts
•**Human-centered computing** → **Virtual reality;** *Participatory design;* •**Information systems** → Digital libraries and archives;

Author Keywords
Mirror world; hybrid space; fantasy worlds; participatory design; digital library services

INTRODUCTION
Public libraries are highly popular in Finland where they are regarded as respected cultural institutions as well as important democratic and non-commercial arenas. They are offered to all citizens and attract people from diverse age groups and demographics [1]. The motivation behind developing a Virtual Reality (VR) interface for a public library was threefold: First, public libraries in Finland are obligated to support citizens' lifelong learning, especially about new technologies. One of the main goals of the VR interface presented in this paper was to provide our partner library with means for these educational purposes so that library staff could use the VR interface for introducing VR technology and its possibilities to citizens. Second, the aim was to create an interface that could enhance and expand the library's existing services, such as its art exhibition, and make them available regardless of time and place.

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Figure 1. The City Library VE mirrors the physical library.

Third, the VR interface was seen as a new way to present library content: it could, for example, make exploring library's literary material more exciting and multisensory. This, in turn, could attract users that library may find hard to reach, such as teenagers.

These aims were agreed upon together with the library administration. Subsequently, we commenced a long-term project with the Oulu City Library that involved a *Participatory Design* (PD) process driving the development of the resulting Virtual Library prototype. The prototype blends a realistic mirror-world like virtual replica of the physical library (Fig. 1) with several imaginary virtual fantasy environments into a *hybrid space* [7, 20] for library content. Interaction within the hybrid space takes place through consumer VR hardware. This VR project built upon our prior 15-year collaboration on furnishing the Oulu City Library with new technologies such as WiFi [11, 22] and large public displays [10].

This paper is structured as follows. In Section 2, we first briefly discuss related work on using realistic mirror-world like virtual environments (VEs) in VR experiences offered in library-like settings. In Section 3, we report the development process of the prototype that was driven by a PD process bringing together us researchers, library staff and library customers. Section 4 presents the design and implementation of the prototype. The setup and findings of the first user evaluation of the prototype with 12 participants are reported in Section 5. Section 6 concludes the paper with design guidelines and ideas for future work.

RELATED WORK

VR experiences involving realistic mirror-world like VEs are widely used in education, therapy and emergency simulations [9]. Public services and spaces can be simulated for treating social phobias and anxiety [18]. Sites with contents of aesthetic value such as cultural heritage sites or museums are particularly suitable for VR applications [16, 8]. There are, however, few VR applications that combine public services and mirror-world like space into a persistent hybrid space, as is done in our prototype.

Head tracking, large stereoscopic FOV as well as haptic controllers provided by contemporary VR hardware offer novel possibilities for the exploration of knowledge. Library services in immersive VR can provide means for serendipitous knowledge finding and exploration [6]. In addition, VR browsing of content leads to better understanding of fields in which spatial dimension is central, such as archaeology or architecture [3].

Oklahoma Virtual Academic Laboratory (OVAL) is a network of VR workstations that combines University of Oklahoma libraries. It provides all library users, including the general public, an access to immersive browsing and collaborative work with digital material and 3D contents from museum archives. OVAL design is based on the idea of embodied browsing, made possible by immersion into the digital space and browsing 3D content in a way that's comparable to interaction with physical stacks [6]. In similar fashion, the Virtual Library contains embodied interaction and uses 3D content for visualizing various library services. In addition, it combines a realistic mirror-world like VE with imaginary VEs, which both contain interactive elements for exploring library contents.

PARTICIPATORY DESIGN PROCESS

The development of the Virtual Library prototype was part of a larger PD process [17, 4, 5]. The process was initiated with a preliminary interview with the library administration, as well as numerous meetings between researchers and library staff. The most significant parts of the PD process were the two multi-stakeholder workshop sessions that brought together library staff, library customers and researchers for creating ideas and gathering specifications for the prototype. Both workshops lasted for four hours each. All the discussions, presentations, and activities in the workshops were audio and/or video-recorded and transcribed. We analyzed the materials with thematic analysis and inductive approach [14].

The first workshop departed with a vision of a future library, the *Hybrid Library*, where 3D web, and AR and VR technologies would be used to enhance the library experience and extend library users' experience beyond the physical library and its services. Since all participants were not familiar with VR/AR technologies, they were given a brief overview of VR/AR technologies and a possibility to experiment with commercial VR demos as well as a very initial prototype of the Virtual Library (effectively a simple noninteractive 3D virtual model of the physical library). The objective of the workshop was idea generation for the Hybrid Library, it's services, and applications. We had 35 participants aged 20-56 years, and 21 of them were female. On workshop process and methods, see [21]. The analysis of the collected research material convinced us to focus primarily on VR interface and postpone ideas related to AR and 3D web interfaces.

The second workshop was arranged six months later, after we had developed the first interactive prototype of the Virtual Library based on the ideas gathered in the first workshop. The second workshop focused exclusively on VR, with the objective to refine selected ideas from the first workshop and the first interactive prototype. This time we had 17 participants - a majority of them had also participated in the first workshop. Their ages varied between 25-58 years, and 10 were female. The aim of the second workshop was to gather more detailed feedback on services and applications, i.e. to guide the design of the next version of the prototype.

PROTOTYPE DESIGN AND IMPLEMENTATION

The design of the *Virtual Library* and the different VEs contained within, is based on major themes that were recurring throughout the research material collected in the workshops. First of all, the structure of the application is based on two main notions: 1) The virtual library needs to contain something familiar that reminds the users of the physical library. Some workshop participants suggested that this familiarity could be achieved by creating a replica of the physical library or by replicating some parts of the building. 2) Further, the participants proposed that the Virtual Library could be a portal to different, imaginative realities, as this would reflect the nature of library content: books, for example, enable travelling to different places and times.

Subsequently, we designed the Virtual Library to have four separate VEs (levels, spaces) with distinct visual qualities and content; the mirror-world like *City Library (Fig. 1)*, and three imaginary layers in *Fantasy Village*, *Study* and *Future Alley*. These four VEs enabled the building of a versatile Virtual Library. We also hypothesized that different environments probably would appeal to different audiences or age groups.

The aesthetic themes for the fantasy VEs were picked up from the workshop materials. The participants naturally came up with other potential ideas as well, however the following three were chosen due to their frequency in the material. 1) A forest was a recurrent theme. We later added a village in the forest to be able to include more details and interesting objects to this VE. 2) Second space that was explicitly mentioned several times was a study with a fireplace or another peaceful, atmospheric indoor space. 3) Third space that came up was a futuristic 'science fiction' environment.

Further, the different services of VEs are also drawn from the recurring ideas that came up in the workshops, especially in the second one. The participants suggested that the Virtual Library could be a new way to search and study all library content (books, art, music etc.); further, they wanted to wander around, explore and play in different environments. In addition, the participants also wished to be able to collaborate with others. Other frequent ideas were to have personalized content (such as personalized book suggestions), guiding avatars and a possibility to communicate with other users; the participants imagined the Virtual Library could be a new kind of social

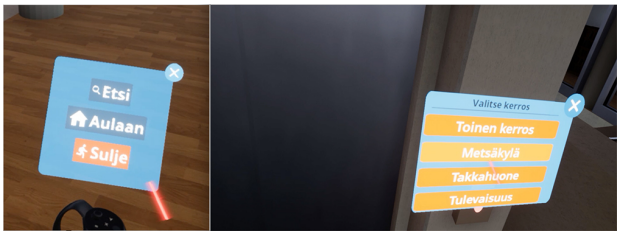

Figure 2. The main menu follows the user's left virtual hand (left). Elevator for transporting into other VEs (right).

Figure 3. A book recommendation in the Fantasy Village VE.

arena, where people with similar interests could meet. However, due to limited resources, we could not implement these latter services to the prototype discussed in this paper.

City Library is the starting VE that contains the bottom two floors of the actual physical library, presented as a detailed mirror-world (Fig. 1). It offers a functionality to search items from the actual library database and browsing their online reviews. The user can also ask for instructions how to navigate to the corresponding virtual location of a book given the book's location in the physical library. This functionality was designed to help in locating items in the physical library. In addition, the level also contains a virtual art exhibition with some interactive content. From this level the user can move to the three fantasy VEs by stepping into an elevator (Fig. 2).

Fantasy Village VE represents a relatively large forest with a lake and a cartoonlike medieval village. The level contains book recommendations selected by library staff and presented both in written and audio format. The recommended books are mostly fantasy literature for young adults. To enhance their discovery, recommendations are hidden within virtual objects scattered around the village (Fig. 3). Some objects also include audio cues, such as a growling bear.

Study VE represents a cozy room with interactive objects the user can manipulate and play with, such as books, bottles, photos and an animated cat. The main interactive service is a large 'magic book' enabling collaborative writing of stories. Writing is done by utilizing a magnet metaphor; for creating a story, the user can drag words one by one from a predetermined list into the book's pages (Fig. 4). Stories can be saved for other users to view. A user can also continue stories saved by previous users. This service was chosen to enable collaborative activity [1].

Future Alley VE resembles a futuristic, slightly bleak urban environment, familiar from science fiction. It offers the same services as the Fantasy Village, i.e. book recommendations. Within this VE the suggested literature is linked to the future.

The Virtual Library was developed with Unreal Engine version 4.17. The 3D meshes and materials are a combination of in-house and commercial assets. The application runs on desktop Windows PC and utilizes Oculus CV1 with Touch controllers as VR hardware. Oculus Touch controllers are used to interact with various objects in the environment. The user can indicate an object of interest through pointing and confirming a selection with the controller button. Interactive objects are indicated with a turquoise glow [12, 13] as well as controller vibration when pointed at. The user can also pick up certain objects by reaching and pressing a dedicated button. Some objects contain menus that are implemented as Unreal 3D Widgets. One of these menus is the main menu; it appears on top of the user's virtual left hand with a separate menu button (Fig. 2). Locomotion within levels uses teleportation instead of continuous movement to reduce cybersickness [15]. A separate WebUI is used for administering the images in the virtual art gallery.

USER EVALUATION

We conducted user evaluation with 12 participants who all had participated in the two PD workshops. The participants' ages varied from 28 to 55. Most of them were library staff (7) and female (10). None of them had prior experience of Oculus Rift and Touch controllers other than during the PD workshops. Half of them had prior experience of 3D games. The evaluation protocol was as follows. First, the participant had a possibility to freely experiment with the prototype and ask help from the researchers if needed. After experimenting, participants were interviewed by utilizing semi-structured thematic interview about their overall experience, different services, interactive elements, participatory process, and feelings of Cybersickness. The data collection priority was on qualitative data. On average, the participants spent 45 minutes in Virtual Library. The entire evaluation process including the interviews lasted 1.5-2 hours.

The participants perceived the combination of mirror and fantasy worlds positively. The overall Virtual Library experience was described with expressions such as "very exciting", "interesting", and "impressive". Many participants explicitly stated that the structure of the Virtual Library, consisting of different VEs, worked very well as books, music, and other library content can be understood as a portal to alternate realities. The participants reported none to very little Cybersickness, usually in the form of slight vertigo when accidentally teleporting into a high location, such as on the top of a rock.

Experiences on different VEs

The participants had somewhat differing opinions on different VEs, based mostly on their personal interests and taste - as we had expected. However, a half of them mentioned that the Fantasy Village was the most pleasant VE or even the most pleasant part of the whole experience; a couple of participants mentioned that the elements from the nature, such

Figure 4. The magic book for collaborative writing in the Study VE.

as falling leaves and sounds of birds were especially appealing. Some participants preferred the Study because it was a more closed and personal space. Other pleasant features connected to these two VEs were their rich visual details, as well as animated animals. The Future Alley produced split opinions: three participants explicitly mentioned they like it lot, while the rest considered it being too empty and bleak—even scary—staying only for a few moments. The City Library (mirror world) yielded similar comments: it was considered too empty, although aesthetically pleasing. Instead of animals, these latter two VEs contained animated human characters that did also draw users' attention; however, many were slightly disappointed that they could not interact with these figures.

Experiences on different services

The most liked services were the book suggestions and book search, although we found out that both services need to be polished. All participants mentioned that the book recommendations should be thematically related to the virtual objects. For example, the virtual fish should represent a sea related book (Fig. 3). Quite many also thought the sudden audio presentations of the books were too intrusive, even though some liked the fact that they could simultaneously explore and listen to the recommendations. Further, almost all users found the book search interface quite complex. Collaborative writing on a magic book was considered a good idea, but the interaction, and especially the dragging of words, was found too difficult. In a similar fashion, the art exhibition was seen as a nice idea, but not really reaping the benefits of interactive VR. For example, interactions with paintings could have provided background information on the artist, artwork, etc. The possibility to manipulate the objects in the Study was found very fascinating by some users; they spent a long time playing and moving objects. On the other hand, some found the handling of objects too difficult and therefore not very appealing.

Overall, we observed that the novel nature of the technology, the aesthetic quality of the prototype and its numerous details prevented participants from concentrating on the actual main services; rather, they wanted to wander around in the VEs and explore the virtual space. To assess the services better, the participants would need to get more familiar with VR experience as a whole to overcome the novelty effect.

DISCUSSION AND FUTURE WORK

The fact that the participants of our study spent on average 45 minutes in the Virtual Library without almost any signs of Cybersickness testifies for successful conceptual design and technical implementation. The structure of the Virtual Library, consisting of a mirror world resembling the physical library and several fantasy VEs, was especially successful. We conclude, based on the qualitative analysis of the PD workshop material and user tests, that the mirror world, where the experience begins, contextualizes the experience of users. The following thematic VEs were interpreted by the users from this framework, and they easily associated them with different literary/media genres. The same structure could be easily utilized by any cultural institution that wishes to present its content through immersive VR, for example museums.

Rich visual details, background audio and interestingly, also natural elements and animals were found very appealing within the VEs. This may be connected to 'technobiophilia' which refers to human beings claimed tendency to focus their attention on "life and lifelike processes as they appear in technology" [19]. On the other hand, it seems that animated human characters, in order to appear pleasant, must possess some human features and offer at least some possibility for interaction or communication. In future, human characters could be used as a narrator for book audio recommendations. While voice is an effective medium to transfer information (e.g. [2]), unexpected audio can be found startling and intrusive by users. For now, we have added an extra step in the book recommendations widget so that the user can decide whether s/he want to read and hear the whole suggestion after finding the interactive object.

Problems with grabbing objects were caused by the mapping of the controller buttons; to fix this, we combined grabbing and general interaction under the same button. Further, even a large virtual world consisting of several VEs gets boring if nothing changes. The goal of this application is to act as an introduction to VR in the library context, so adding novelties is not that central. However, if the app would be used regularly by the same users, the services such as the art exhibition and book suggestions should be renewed relatively often. In that case the application must include a possibility to easily remove/add information so that the staff of different institutions can update services. For now, a web interface exists for administrating the images within the art exhibition.

In terms of future work, we are currently developing the next incremental version of the prototype, given the results of the user evaluation presented in this paper. We have agreed with our partner library that few sets of VR goggles will be installed in the library, to make the Virtual Library available to all library customers. This will allow us to collect quantitative data on the use of the prototype from a large number of real library customers.

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REFERENCES

1. Svanhild Aabø, Ragnar Audunson, and Andreas Vårheim. 2010. How do public libraries function as meeting places? *Library & Information Science Research* 32, 1 (2010), 16–26.
2. Robert K Atkinson, Richard E Mayer, and Mary Margaret Merrill. 2005. Fostering social agency in multimedia learning: Examining the impact of an animated agent's voice. *Contemporary Educational Psychology* 30, 1 (2005), 117–139.
3. Juan A. Barceló, Maurizio Forte, and Donald H. Sanders. 2000. *Virtual reality in archaeology*. ArchaeoPress Oxford.
4. Gro Bjerknes and Tone Bratteteig. 1995. User participation and democracy: A discussion of Scandinavian research on system development. *Scandinavian Journal of information systems* 7, 1 (1995), 1.
5. Susanne Bødker. 2003. A for Alternatives. *Scandinavian Journal of Information Systems* 15, 1 (2003), 1.
6. Matt Cook. 2018. Virtual Serendipity: Preserving Embodied Browsing Activity in the 21st Century Research Library. *The Journal of Academic Librarianship* 44, 1 (2018), 145–149.
7. Adriana De Souza e Silva. 2006. From cyber to hybrid: Mobile technologies as interfaces of hybrid spaces. *Space and culture* 9, 3 (2006), 261–278.
8. Wolfgang Hürst, Xhi Jia Tan, and Ferdinand de Coninck. 2016. Using Digital Extensions to Create New VR Museum Experiences. In *Proceedings of the 13th International Conference on Advances in Computer Entertainment Technology*. ACM, 45.
9. Lasse Jensen and Flemming Konradsen. 2018. A review of the use of virtual reality head-mounted displays in education and training. *Education and Information Technologies* 23, 4 (2018), 1515–1529.
10. Hannu Kukka, Tommi Heikkinen, Henri Kytökangas, Taru Tanska, and Timo Ojala. 2018. UbiLibrary: Situated large public display as interactive interface to library services. In *Proceedings of the Academic Mindtrek Conference 2018 (Mindtrek 2018)*. ACM.
11. Timo Ojala, Jukka Orajärvi, Katriina Puhakka, Ilari Heikkinen, and Juhani Heikka. 2011. panOULU: Triple helix driven municipal wireless network providing open and free Internet access. In *Proceedings of the 5th International Conference on Communities and Technologies*. ACM, 118–127.
12. Minna Pakanen and Leena Arhippainen. 2014. User experiences with web-based 3D virtual travel destination marketing portals: the need for visual indication of interactive 3D elements. In *Proceedings of the 26th Australian Computer-Human Interaction Conference on Designing Futures: the Future of Design*. ACM, 430–439.
13. Minna Pakanen, Leena Arhippainen, Seamus Hickey, and Antti Karhu. 2013. Visual Indication of Interactive 3D Elements in 3D Virtual Environments. In *Proceedings of International Conference on Making Sense of Converging Media*. ACM, 1.
14. Michael Quinn Patton. 2005. Qualitative research. *Encyclopedia of statistics in behavioral science* (2005).
15. Lisa Rebenitsch and Charles Owen. 2016. Review on cybersickness in applications and visual displays. *Virtual Reality* 20, 2 (01 Jun 2016), 101–125.
16. Nurul Fathihin Mohd Noor Shah and Masitah Ghazali. 2018. A Systematic Review on Digital Technology for Enhancing User Experience in Museums. In *International Conference on User Science and Engineering*. Springer, 35–46.
17. Jesper Simonsen and Toni Robertson. 2012. *Routledge international handbook of participatory design*. Routledge. 86–116 pages.
18. Paul R Smokowski and Katie Hartung. 2003. Computer simulation and virtual reality: Enhancing the practice of school social work. *Journal of technology in human services* 21, 1-2 (2003), 5–30.
19. Sue Thomas. 2013. *Technobiophilia: Nature and cyberspace*. A&C Black.
20. Johanna Ylipulli, Jenny Kangasvuo, Toni Alatalo, and Timo Ojala. 2016. Chasing Digital Shadows: Exploring future hybrid cities through anthropological design fiction. In *Proceedings of the 9th Nordic Conference on Human-Computer Interaction*. ACM, 78.
21. Johanna Ylipulli, Anna Luusua, and Timo Ojala. 2017. On Creative Metaphors in Technology Design: Case Magic. In *Proceedings of the 8th International Conference on Communities and Technologies*. ACM, 280–289.
22. Johanna Ylipulli, Tiina Suopajärvi, Timo Ojala, Vassilis Kostakos, and Hannu Kukka. 2014. Municipal WiFi and interactive displays: Appropriation of new technologies in public urban spaces. *Technological Forecasting and Social Change* 89 (2014), 145–160.